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APPARATUS AND METHOD FOR LAMINATING SUBSTRATES FOR LIQUID CRYSTAL PANEL

[Abstract]

PROBLEM TO BE SOLVED: To align substrates by externally moving substrates in XYθ directions outside of pressurizing plates while keeping only the space between the pressurizing plates in a sealed state.

SOLUTION: The pressurizing plates 1, 2 holding two substrates A, B are moved nearer to each other so as to seal the space between the peripheral edges 1a, 2a of the plates by a movable sealing means 4 to form a section of a closed space S while the substrates A, B are moved nearer to each other to form a specified gap. Then while the air in the closed space S is evacuated, the pressurizing plates 1, 2 are relatively moved and adjusted in

along $XY\theta$ directions to roughly align the substrates A, B. After a specified vacuum degree is obtained, the movable sealing means 4 is deformed to move the substrates A, B further nearer to each other the position where the gap between the substrates A, B is sealed with an annular adhesive C. In this state, the pressurizing plates 1, 2 are relatively moved and adjusted in the $XY\theta$ directions to finely align the substrates. Then the substrates are released from only one of the plates 1, 2 to return the closed space S to the atmospheric pressure so that the gap is uniformly pressed by the pressure difference between the inside and outside of the substrates A, B to form a specified gap.

[Claims]

[Claim 1]

An apparatus for laminating substrates for a liquid crystal panel in which two sheets of substrates A and B which can be freely attached and detached with respect to a pair of upper and lower pressing plates 1 and 2 are folded in a vacuum state, adjusted and moved relatively in XYθ directions by a position determining unit 8 so as to be roughly aligned and precisely aligned, and then, pressed to fill up to a certain gap, comprising: a support means 3 for supporting the substrates A and B installed on the facing surfaces of the both pressing plats 1 and 2 such that they cannot be moved; a movable seal means 4 for supporting freely movement relatively in the XYθ directions in a state that the circumferential portions 1a and 2a facing the both pressing plates 1 and 2 are hermetically closed, and elastically deformed in a vertical direction; a first pressing means 5 for moving the both pressing plates 1 and 2 to approach relatively with each other, forming a closed space (S) such that the both substrates A and B can be surrounded between the both pressing plates 1 and 2, and approaching the both substrates A and B each other up to a certain interval; a suction means 6 for removing air in the closed space (S) to form a vacuum therein; a second pressing means 7 for approaching the both substrates A and B which has been approached by the first pressing means 5 to be closer up to a position where the substrates A and B can be hermetically closed with an annular adhesive (C); and a position determining unit 8 for adjusting and moving the both pressing plates 1 and 2 relatively in the XYθ directions in a state that the first and second pressing means 5 and 7 are operating, and

installed outside the closed space (S).

[Claim 2]

A method for laminating substrates for a liquid crystal panel in which two sheets of substrates A and B which can be freely attached and detached with respect to a pair of upper and lower pressing plates 1 and 2 are folded in a vacuum state, adjusted and moved relatively in XYθ directions by a position determining unit 8 so as to be roughly aligned and precisely aligned, and then, pressed to fill up to a certain gap, comprising: a step in which the two sheets of substrates A and B are supported on facing surfaces of the both pressing plates 1 and 2 such that they cannot be moved; a step in which as the both pressing plates 1 and 2 approach, the facing circumferential portions 1a and 2a are sealed with a movable seal means 4 which can be elastically deformed in a vertical direction, a closed space (S) is formed such that the both substrates A and B can be surrounded and the both substrates A and B are made to approach up to a certain interval in the closed space (S); a step in which the air in the closed space (S) is removed, the both pressing plates 1 and 2 are adjusted and moved relatively in the XYθ directions, and both substrates A and B are roughly aligned; a step in which after the closed space (S) obtains a certain degree of vacuum, the movable seal means 4 is deformed so that the both substrates A and B can approach to be closed up to a position where the both substrates A and B are closed with an annular adhesive (C); a step in which the both pressing plates 1 and 2 are adjusted and moved relatively in the XYθ directions and the move closely approached substrates A and B are precisely aligned; and

a step in which one of the substrates A and B is released from one of the pressing plats 1 and 2, the closed space (S) is returned to have the atmospheric pressure, and the both substrates A and B are uniformly pressed and filled up to a certain gap according to a difference between an inner pressure and an outer pressure of the substrates A and B, and the above steps are sequentially performed.

[Claim 3]

The apparatus of claim 1, wherein the second pressing means 7 includes a flexible thin plate member 7b which closes a recess portion 1b formed at a central portion of the facing surface of one pressing plate 1, supports the substrate 'A' such that it cannot be moved, and is elastically deformed only in the vertical direction, and a pressing unit 7c which evacuates air from the recess portion 1b closed by the flexible thin plate member 7b and deforms the flexible thin plate member 7b so that it can bounce up toward the other substrate 'B' when the substrates are precisely aligned.

[Claim 4]

The method of claim 2, further comprising a step in which one substrate A is supported so as not to be moved on a flexible thin plate member 7b which closes a recess portion 1b formed at a central portion of the facing surface of one pressing plate 1 and is elastically deformed only in the vertical direction; a step in which the substrates are roughly aligned by making an internal pressure of the closed recess portion 1b and that of the

closed space (S) same; and a step in which after the rough aligning, when the closed space (S) obtains a certain degree of vacuum, the flexible thin plate member 7b is deformed to bounce up according to an increase in the internal pressure of the closed recess portion 1b, and the substrate A supported thereon is made to approach more closely to the other substrate B.

[Claim 5]

The method of claim 2 or 4, wherein a suitable amount of liquid crystals is injected between the both substrates A and B before the substrates are roughly aligned.

[Title of the Invention]

APPARATUS AND METHOD FOR LAMINATING SUBSTRATES FOR LIQUID CRYSTAL PANEL

[Detailed description of the Invention]

[Field of the Invention]

The present invention relates to an apparatus and method for laminating substrates for a liquid crystal panel for aligning (rough aligning and fine aligning) two sheets of substrates in a vacuum state in a process of fabricating the liquid crystal panel used for a liquid crystal display (LCD), and more particularly, to an apparatus and method for laminating substrates for a liquid crystal panel in which two sheets of substrates, of which detachment and attachment are freely supported by a pair of pressing plates, are folded in a vacuum state, roughly aligned and precisely aligned by adjusting and moving them relatively in XYθ directions by a position determining unit, and then pressed to fill to have a certain gap.

[Description of the Prior Art]

In a related art apparatus and method for laminating substrates for a liquid crystal panel as shown in Figure 5, a vacuum chamber 11, which surrounds a pair of upper and lower pressing plates 1' and 2' and a position determining unit 8' such as an XY table, is formed to be opened/closed freely. A driving shaft 8c' connecting the position determining unit 8' and a driving source 8b' penetrates the vacuum chamber 11 by means of a vacuum penetrating part 12 such as bellows. After the interior of the vacuum

chamber 11 is closed to be form a vacuum therein, the position determining unit 8' is operated through the driving shaft 8c'to thereby adjust and move the both pressing plates 1' and 2' in the XYθ directions to roughly and precisely aligning the both substrates A and B.

[Problems to be solved by the Invention]

However, in the related art apparatus and method for laminating the substrates for the liquid crystal panel, since the substrates are aligned in the XYθ directions in the vacuum chamber by driving the position determining unit from outside, vacuum penetrating components of the driving shaft are complicated, forming a vacuum inside and outside the vacuum chamber incurs a high cost. In addition, a considerable force is required for roughly aligning and precisely aligning according to viscosity of a sealant and there are many restrictions in a driving form. Moreover, because the vacuum chamber encompass the pair of upper and lower pressing plates and the position determining unit, the internal space where a vacuum to be formed increases, which needs to increase capacity of a vacuum pump and limits the size of used substrates, so a large-scale substrate cannot be fabricated.

An object of the present invention as recited in claims 1 and 2 is to hermetically close the portion only between both pressing plates and move it in XYθ directions from outside and aligned. An object of the present invention as recited in claims 3 and 4 in addition to the object as recited in claim 1 or 2 is to prevent partial pressing onto each substrate regardless of flatness or parallel precision of a rigid pressing plate. An object of the present invention as recited in claim 5 in addition to the object as recited in

claim2 or 4 is to fabricate a liquid crystal panel without injecting liquid crystals in a follow-up process.

[Means for solving the problem]

To achieve these and other advantages and in accordance with the purpose of the present invention, as embodied and broadly described herein, there is provided an apparatus for laminating substrates for a liquid crystal panel as recited in claim 1 including: a support means 3 for supporting the substrates A and B installed on the facing surfaces of the both pressing plats 1 and 2 such that they cannot be moved; a movable seal means 4 for supporting freely movement relatively in the XYθ directions in a state that the circumferential portions 1a and 2a facing the both pressing plates 1 and 2 are hermetically closed, and elastically deformed in a vertical direction; a first pressing means 5 for moving the both pressing plates 1 and 2 to approach relatively with each other, forming a closed space (S) such that the both substrates A and B can be surrounded between the both pressing plates 1 and 2, and approaching the both substrates A and B each other up to a certain interval; a suction means 6 for removing air in the closed space (S) to form a vacuum therein; a second pressing means 7 for approaching the both substrates A and B which has been approached by the first pressing means 5 to be closer up to a position where the substrates A and B can be hermetically closed with an annular adhesive (C); and a position determining unit 8 for adjusting and moving the both pressing plates 1 and 2 relatively in the XYθ directions in a state that the first and second pressing means 5 and 7 are operating, and installed outside the closed space (S).

A method for laminating substrates for a liquid crystal panel as recited in claim 2, includes: a step in which the two sheets of substrates A and B are supported on facing surfaces of the both pressing plates 1 and 2 such that they cannot be moved; a step in which as the both pressing plates 1 and 2 approach, the facing circumferential portions 1a and 2a are sealed with a movable seal means 4 which can be elastically deformed in a vertical direction, a closed space (S) is formed such that the both substrates A and B can be surrounded and the both substrates A and B are made to approach up to a certain interval in the closed space (S); a step in which the air in the closed space (S) is removed, the both pressing plates 1 and 2 are adjusted and moved relatively in the XYθ directions, and both substrates A and B are roughly aligned; a step in which after the closed space (S) obtains a certain degree of vacuum, the movable seal means 4 is deformed so that the both substrates A and B can approach to be closed up to a position where the both substrates A and B are closed with an annular adhesive (C); a step in which the both pressing plates 1 and 2 are adjusted and moved relatively in the XYθ directions and the move closely approached substrates A and B are precisely aligned; and a step in which one of the substrates A and b is released from one of the pressing plats 1 and 2, the closed space (S) is returned to have the atmospheric pressure, and the both substrates A and B are uniformly pressed and filled up to a certain gap according to a difference between an inner pressure and an outer pressure of the substrates A and B, and the above steps are sequentially performed.

The second pressing means 7 of the apparatus of claim 1 as recited in claim 3 includes a flexible thin plate member 7b which closes a recess

portion 1b formed at a central portion of the facing surface of one pressing plate 1, supports the substrate 'A' such that it cannot be moved, and is elastically deformed only in the vertical direction, and a pressing unit 7c which sucks air from the recess portion 1b closed by the flexible thin plate member 7b and deforms the flexible thin plate member 7b so that it can bounce up toward the other substrate 'B' when the substrates are precisely aligned.

The method as recited in claim 4 comprises further to claim 2; a step in which one substrate A is supported so as not to be moved on a flexible thin plate member 7b which closes a recess portion 1b formed at a central portion of the facing surface of one pressing plate 1 and is elastically deformed only in the vertical direction; a step in which the substrates are roughly aligned by making an internal pressure of the closed recess portion 1b and that of the closed space (S) same; and a step in which after the rough aligning, when the closed space (S) obtains a certain degree of vacuum, the flexible thin plate member 7b is deformed to bounce up according to an increase in the internal pressure of the closed recess portion 1b, and the substrate A supported thereon is made to approach more closely the other substrate B.

In the method as recited in claim 5 in addition to claim 2 or 4, a suitable amount of liquid crystals is injected between the both substrates A and B before the substrates are roughly aligned.

[Operation]

The present invention recited in claims 1 and 2 features that pressing

plates supporting two sheets of substrates move to approach to close by means of a movable seal unit mutual circumferential portions to thereby form a closed space, both substrates approach until they have a certain gap therebetween, air in the closed space is removed, the both pressing plates are adjusted and moved relatively in XYθ directions, and both substrates are roughly aligned, and then, when a certain vacuum degree is obtained, the movable seal unit is deformed to make both substrates approach until they are closed with an annular adhesive, and in this state, the both pressing plates are adjusted and moved relatively in the XYθ directions, both substrates are precisely aligned and then released from only one side of the pressing plates, and then, the closed space is returned to an atmospheric pressure so that the both substrates can be uniformly pressed according to a pressure difference made between the inside and the outside to thereby form a certain gap.

The present invention as recited in claims 3 and 4 features with respect to the construction as recited in claim 1 that a second pressing means includes a flexible thin plate member for closing a recess portion formed at the central portion of a facing surface of one pressing plate and elastically deformed only in a vertical direction so as to support to prevent movement of one substrate; and a pressing unit for sucking a gas in the recess portion closed by the flexible thin plate member to deform the flexible thin plate member to bounce up toward the other substrate during fine aligning, or features with respect to the constructed as recited in claim 2 that a step of supporting to prevent movement of one substrate on the flexible thin plate member closing the recess portion formed at the central

portion of the facing surface of one pressing plate and elastically deformable only in the vertical direction; a step of performing aligning roughly by making an internal pressure of the closed recess portion and an internal pressure of the closed space same; a step of deforming the flexible thin plate member so as to bounce up according to increase in the internal pressure of the closed recess portion after the interior of the closed space reaches a vacuum degree following the roughly aligning, and moving the substrate supported thereon so as to be closed to the other substrate. By doing that, after the roughly aligning, the flexible thin plate member is deformed to bounce up according to the increase in the internal pressure of the closed recess portion, the substrate supported thereon is moved to more approach the other substrate, and then, the gap between the both substrates is closed by the annular adhesive 'C', whereby the both substrates can be uniformly filled near a final gap during precisely aligning.

The present invention as recited in claim 5 features with respect to the construction as recited in claim 2 or 4 that a suitable amount of liquid crystals are injected between both substrates before performing the roughly aligning. Thus, the atmosphere in the closed space is returned to the atmospheric pressure and the both substrates are uniformly pressed to be filled according to the difference between pressures formed the outside and the inside of the both substrates, and in the state that the liquid crystals are sealed, a certain gap can be formed.

[Embodiment of the invention]

The present invention will now be described with reference to the

accompanying drawings. As shown in Figures 1 and 2, an upper pressing plate 1 is an upper base plate which is supported to be reciprocally moved in a vertical direction freely but cannot be moved in XYθ directions, and a lower pressing plate 2 is a lower base plate which is supported to be freely adjusted and moved in the XYθ directions through a position determining unit 8 such as, for example, an XY table on a fixing plate 9. Two sheets of glass substrates A and B adsorbed and supported on facing surfaces of the upper and lower base plates 1 and 2 are aligned at a vacuum atmosphere.

The upper and lower base plates 1 and 2 are formed of a rigid body such as a metal or carbon. A plurality of suction holes as a support unit 3 are formed at the central portion of the facing surfaces to prevent movement of the both substrates A and B. The suction holes 3 and an absorption source (not shown) such as a vacuum pump are connected through a pipe. An operation of the absorption source is controlled by a controller (not shown). Absorption operation is initiated at an initial stage that the both substrates A and B are set. After the both substrates A and B are precisely aligned, one of the substrates, namely, the upper substrate 'A' in this embodiment, is released from being adsorbed, and then, after the closed space 'S' (to be described) is returned to the atmospheric pressure, the lower substrate 'B' is released from being adsorbed and returned to its initial state.

The substrates A and B are formed as a color filter and TFT substrates with a desired pattern formed thereon. An annular adhesive 'C' is coated on the edge portion along a circumferential portion of one of the facing surfaces of the substrates, namely, of the lower substrate 'B' in this

embodiment, and a plurality of spacers (not shown) can spread on the other substrate as necessary.

A movable seal unit 4, which is positioned between a circumferential portion 1a of the upper base plate 1 and a circumferential portion 2a of the lower base plate 2 to support the both bate plates so as to be movable in the XYθ directions in a state that the both base plates 1 and 2 are maintained in a closed state, is installed in an annular form to surround the both substrates A and B. In this embodiment, the movable seal unit 4 includes a movable block 4a having a circular or spherical shape in its section according to a plane form of the upper and lower base plates 1 and 2, an annular seal material 4b which contact with or released from the circumferential portion 1a of the upper base plate 1 mounted on an upper surface of the movable block 4a, and elastically deformed in a vertical direction of such as an O ring, a driving vacuum seal 4c which usually contacts with the circumferential portion 2a of the lower base plate 2 mounted on a lower surface of the movable block 4a and uses, for example, a vacuum grease as necessary, and a load support ball 4d supporting such that force such as weight of the upper base plate 1 or the movable block 4a does not work on the driving vacuum seal 4c.

In particular, as necessary, a plurality of connection pins 4e are penetratingly inserted over the upper base plate 1 and the movable block 4a in order to integrally connect them such that they can be moved in the vertical direction but not in the XYθ directions. Preferably, an elastic member 4f such as a tensile spring is installed at the movable block 4 and the lower base plate 2 in order to prevent separation of them in the vertical direction.

A first pressing unit formed of, for example, a vertically driving cylinder is connected with the upper base plate 1. An operation of the first pressing unit 5 is controlled by a controller (not shown). In an initial state where the substrates A and B are set, the upper base plate 1 is in a standby state as indicated by a dotted line as shown in Figures 1 and 2a. When the substrates A and B are completely set, the base plate 1 is lowered, a space 'S' closed between the upper and lower substrates 1 and 2 surrounds the both substrates A and B as indicated by a straight line in Figure 1 and Figure 2b. After the both substrates A and b are precisely aligned, of after the closed space 'C' is returned to the atmospheric pressure, the base plate 1 is lifted to be returned to its initial state.

As indicated by a reference numeral 6 in Figure 1, an suction unit is installed in the closed space 'S', which is connected with a vacuum pump installed outside and sucking air in the closed space 'S' to obtain a certain vacuum degree therein. An operation of the suction unit 7 is controlled by the controller (not shown). The suction unit initiates sucking in the closed space 'S' when the closed space 'S' is formed as the upper and lower base plates 1 and 2 approach. And then, after the both substrates A and B are precisely aligned, the suction unit supplies air to the closed space 'S' to return it to the atmospheric pressure.

A second pressing unit 7 is installed to make the both substrates A and B which have approached by the first pressing unit 5 more approach up to a position where they are closed with the annular adhesive 'C'. In this embodiment, the second pressing unit 7 is formed as a cylinder 7a which can be expanded and contracted in a vertical direction from an upper

surface of the movable block 4a to the circumferential portion 1a of the upper base plate 1. By contracting the cylinder 7a in the vertical direction, the annular seal 4b can be compressed to be deformed in the vertical direction, whereby the both substrates A and B can be more pressed. An operation of the second pressing unit 7 is controlled by the controller (not shown). At an initial state, the second pressing unit is expanded in the vertical direction as shown in Figure 2a. After the both substrates A and B are roughly aligned, the second pressing unit 7 is contracted as shown in Figure 2c. And then, after the both substrates A and B are precisely aligned or after the closed space 'S' (to be described) is returned to the atmospheric pressure, the second pressing unit 7 is lifted to be returned to its initial state.

The position determining unit 8 including the XY table 8a and the driving source 8b for moving the lower base plate 2 in the XYθ directions are connected with a lower surface of the lower base plate 2, namely, the outer side of the closed space 'S'. By driving the driving source 8b based on data of marks indicated at both substrates A and B and outputted from a detecting unit 8c including a microscope and a camera, the lower base plate 2 and the lower substrate 'B' supported thereon can be adjusted and moved in the XYθ directions, and the roughly aligning and precisely aligning are performed.

A buffer 10 can be formed as necessary at a central portion which contacts with the both substrates A and B of the facing surfaces of the upper and lower base plates 1 and 2. The buffer 10 is made of a material with excellent cushion characteristics and has such a thickness as not to generate misalignment when the both substrates A and B are adjusted and

moved in the XYθ directions by the position determining unit 8. In this embodiment, the buffer 10 with a thickness of a few millimeters is formed only on the facing surface 2b of the lower base plate 2, but the present invention is not limited thereto, and the buffer can be installed at both facing surfaces of the upper and lower base plates 1 and 2 or only at the facing surface of the upper base plate 1.

The method for laminating the substrates for a liquid crystal panel will now be described according to a process order.

First, as shown in Figure 2a, the substrates A and B are set to be pre-aligned on the facing surfaces of the upper and lower base plates 1 and 2. And then, the both substrates A and B are adsorbed and supported by the support unit 3 so that they cannot be moved.

Thereafter, as shown in Figure 2b, the upper and lower base plates 1 and 2 approach by operating the first pressing unit 5, and the circumferential portion 1a of the upper base plate 1 is tightly attached with the annular seal 4b. Then, the closed space 'S' is formed to encompass the both substrates A and B sealed between the upper and lower base plates 1 and 2.

At the same time, the both substrates A and B approach up to a certain interval therebetween and face with a gap of 1mm or below. However, the substrate 'A' does not contact with the annular adhesive 'C' and the closed space 'S' communicates between the both substrates A and B.

Thereafter, as air is removed from the closed space 'S' by operating the suction unit 6, the space 'S' has a vacuum formed therein, and also air is removed from the interval between the both substrates A and B to form a

vacuum therein. IN this state, the upper and lower base plates 1 and 2 are adjusted and moved relatively in the XYθ directions by the position determining unit 8, and the both substrates A and B are roughly aligned.

When a certain degree of vacuum is obtained, as shown in Figure 2c, the upper and lower base plates 1 and 2 approach further by operating the second pressing unit 7 to compress and deforms the annular seal 4b, according to which the both substrates A and B approach to be more closed. And then, as the substrate 'A' is tightly attached on the annular adhesive 'C' coated on the substrate 'B', the both substrates A and B are hermetically closed. IN this state, the upper and lower base plates 1 and 2 are adjusted and moved in the XYθ directions by operating the position determining unit 8, and the both substrates A and B are precisely aligned.

Subsequently, as shown in Figure 2d, the upper substrate 'A' is released from the upper base plate 1 by operating the support unit 3, and air is applied into the closed space 'S' by operating the suction unit 6 to return it to the atmospheric pressure. By doing that, the both substrates A and B are uniformly pressed and filled according to the difference of pressure made between the inside and outside thereof and a certain gap is formed therebetween.

In this case, before performing the roughly aligning, specifically when the both substrates A and B are set, a suitable amount of liquid crystals can be sealed in a suitable state. Then, the closed space 'S' can be returned to the atmospheric pressure, so that the both substrates A and B can be uniformly pressed and filled according to the difference of pressure formed inside and outside the substrates A and B. With the liquid crystals

sealed, a certain gap can be formed, and a liquid crystal panel can be fabricated without injecting liquid crystals in a follow-up process.

Thereafter, when the closed space 'S' is returned to have the atmospheric pressure, the upper and lower base plates 1 and 2 are released by operating the first pressing unit 5, the closed space 'S' is opened, the aligned substrates A and B are taken out, and then, the above-described operations are repeatedly performed.

Accordingly, in the state that only the upper and lower base plates 1 and 2 are hermetically closed, they can be moved in the XYθ directions and aligned from outside. As a result, the position determining unit 8 or the driving source 8b can be installed in the air, general components can be used and a vacuum penetrating component is not necessary, making the structure simple. In addition, since no cost incurs for forming a vacuum and not much force is required for the roughly aligning and precisely aligning, there is no limitation in a driving form. Moreover, the vacuum space can be minimized, which reduces capacity of the vacuum pump as much, and productivity of a large-scale substrate can be enhanced.

When the buffer 10 with the excellent cushion characteristics is installed as necessary on one or both facing surfaces of the upper and lower base plates 1 and 2 such that misalignment does not occur in the adjusting and moving in the XYθ directions, a phenomenon that only one side of the upper and lower base plates 1 and 2 contacts is prevented and thus a uniform gap can be easily formed.

Figures 3 and 4d shows a different embodiment of the present invention. This embodiment is different from the former embodiment in that,

in place of the cylinder 7a which is installed from the upper surface of the movable block 4a to the circumferential portion 1a of the upper base plate 1 and expands and contracts in the vertical direction, the second pressing unit 7 includes a flexible thin plate member 7b which closes a recess portion 1b formed at the central portion of the facing surface of the upper base plate 1, supports the upper substrate 'A' such that it cannot be moved, and is elastically deformed only in the vertical direction, and a pressing unit 7c which sucks air in the recess portion 1b closed by the flexible thin plate member 7b and deforms the flexible thin plate member 7b so that it can bounce up toward the lower substrate 'B' when the substrates are precisely aligned. The other construction is the same as the former embodiment as shown in Figures 1 and 2.

The flexible thin plate member 7b is made of a metal film such as stainless steel so that it can be elastically deformed in the vertical direction but not in the XYθ directions, and includes a plurality of suction holes as a support unit 3 formed at the central portion thereof. The pressing unit 7c, which is controlled by a controller (not shown), sucks air so that an internal pressure of the closed recess portion 1b is the same as that of the closed space 'S' by means of the suction unit 6 in the above state as shown in Figure 4a and until the roughly aligning is performed. After the roughly aligning is performed, as shown in Figure 4c, the pressing unit 7c applies air so that the internal pressure of the closed recess portion 1b can be higher than that of the closed space 'S'.

After the roughly aligning is performed, as shown in Figure 4c, the flexible thin plate member 7b is deformed to bounce up according to

increase in the internal pressure of the closed recess portion 1b, and the upper substrate 'A' supported thereon is made to approach closer the lower substrate 'B', which is then closed with the annular adhesive 'C', whereby the both substrates A and B can be uniformly filled up to near a final gap when they are precisely aligned.

As a result, compared with the former embodiment as shown in Figures 1 and 2, the rigid upper and lower base pates 1 and 2 can easily cause the partial pressing of the substrates A and B easily according to the flatness of the facing surfaces or parallel precision between the base plates, but the partial pressing of the substrates A and B can be completely prevented and a product cannot be damaged.

In this embodiment, the upper pressing plate 1 is the upper base plate which can be reciprocally moved in the vertical direction freely and the lower pressing plate 2 is the lower base plate which is supported to be freely adjusted and moved in the XYθ directions. But the present invention is not limited thereto, and the upper base plate can be supported to be adjusted and moved freely in the XYθ directions and the lower base plate can be supported to be movable reciprocally in the vertical direction freely. The aligning is performed under the vacuum atmosphere, but the present invention is not limited thereto and aligning can be performed under a special gas atmosphere.

The substrates A and B, the support unit 3, the movable seal unit 4, the first pressing unit 5, the suction unit 6, the second pressing unit 7 and the position determining unit 8 are not limited to the illustrated structure and can have any structure so long as they can operate in the same manner.

Especially, the support unit 3 for supporting the substrates A and B such that they cannot be moved can use vacuum and absorption by using a vacuum difference by means of the suction unit 6 if a vacuum degree in the closed space 'S', and in this case, if the closed space 'S' has such a high vacuum degree that the vacuum difference cannot be used, an electrostatic chuck or an adhesive film can be used as the support unit 3 so that the substrates A and B cannot be moved. Instead of the driving vacuum seal 4c of the movable seal unit 4, a magnetic fluid type vacuum seal can be used.

[Effect of the invention]

As so far described, according to the present invention as recited in claims 1 and 2, the pressing plates supporting two sheets of substrates thereon are moved to approach each other, the mutual circumferential portions are closed by means of a movable seal unit to form a closed space, the both substrates approach up to a certain interval therebetween, the both pressing plates are adjusted and moved in the XYθ directions while moving air existing in the closed space, both substrates are roughly aligned, the movable seal unit is deformed to make both substrates approach up to a position where they can be closed with the annular adhesive when a certain vacuum degree is obtained, the both pressing plates are adjusted and moved in the XYθ directions, both substrates are precisely aligned, the substrate is released only from one pressing plate, and then, the closed space is returned to have the atmospheric pressure, so that the both substrates can be uniformly pressed and filled according to the difference between the inner pressure and outer pressure of both substrates and a gap

is formed. Thus, in the state that only the portion between both pressing plates are hermetically closed, they can be moved in the XYθ directions to be aligned from outside.

Accordingly, compared with the related art in which the position determining unit is moved in the XYθ directions for aligning in the vacuum chamber upon receiving a driving force from outside, the position determining unit or its driving source can be installed in the air, general components can be used, and a vacuum penetrating component does not need to be used, making the structure simple. In addition, since no cost incurs for forming a vacuum and not much force is required for the roughly aligning and precisely aligning, there is no limitation in a driving form. Moreover, the vacuum space can be minimized, which reduces capacity of the vacuum pump as much, and productivity of a large-scale substrate can be enhanced.

In addition to the effect of the present invention of claims 1 and 2, according to the present invention as recited in claims 3 and 4, after the roughly aligning, the flexible thin plate member is deformed to bounce up according to increase in the internal pressure of the closed recess portion, and the substrate supported thereon is made to approach closer the other lower substrate, which is then closed with the annular adhesive 'C', whereby the both substrates can be uniformly filled up to near the final gap when they are precisely aligned. Accordingly, partial pressing of each substrate can be prevented regardless of the flatness or parallel precision of the pressing plates. Therefore, although the rigid pressing plate can cause the partial pressing of each substrate according to the flatness of the facing

surface or the parallel precision between the base plates, the partial pressing of each substrate can be completely prevented and a product is not damaged.

In addition to the effect of the present invention of claims 2 or 4, according to the present invention as recited in claim 5, since the closed space is returned to have the atmospheric pressure, both substrates can be uniformly pressed and filled according to the difference of inner pressure and outer pressure of both substrates, and in the state that liquid crystals are sealed, the certain gap can be formed. Thus, without injecting liquid crystals in a follow-up process, a liquid crystal panel can be fabricated.

[Description of drawings]

Figure 1 is a front vertical sectional view of an apparatus for laminating substrates for a liquid crystal panel in accordance with a first embodiment of the present invention;

Figures 2a to 2d are sectional views showing a sequential process of a method for fabricating a liquid crystal panel;

Figure 3 is a front vertical sectional view of an apparatus for laminating substrates for a liquid crystal panel in accordance with a second embodiment of the present invention;

Figures 4a to 4d are sectional views showing a sequential process of a method for fabricating a liquid crystal panel; and

Figure 5 is a front vertical sectional view of an apparatus for laminating substrates for a liquid crystal panel in accordance with a conventional art.